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**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE  
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

Applicant(s): Berger et al.  
Application No.: 09/240,275  
Filed: January 29, 1999  
For: Adaptive Decision Regions and Metrics  
Group Art Unit: 2634  
Examiner: Kim, Kevin

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Appeal Brief Transmittal

Submitted herewith for the above-identified application are the following:

1. Three copies of an Appeal Brief.
2. Three copies of the Amendment.
3. The Commissioner is hereby authorized to charge any additional fees which may be required in this application under 37 C.F.R. §§1.16-1.17 during its entire pendency, or credit any overpayment, to Deposit Account No. 50-1214. Should no proper payment be enclosed herewith, as by a check being in the wrong amount, unsigned, post-dated, otherwise improper or informal or even entirely missing, the Commissioner is authorized to charge the unpaid amount to Deposit Account No. 50-1214. This sheet is filed in triplicate.

Respectfully submitted,

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Applicant(s): Berger et al.

Serial No.: 09/240,275

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Title: Adaptive Decision Regions and Metrics

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**Applicant's Brief On Appeal**

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**Applicant's Brief On Appeal**

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**Real Party In Interest**

The real party in interest is Northrop Grumman Corporation, by virtue of an Assignment from the inventors: Harvey L. Berger; Samuel J. Friedberg and James C. Becker; to TRW Inc., recorded on Reel/Frame 9741/0344 and from TRW, Inc., to Northrop Grumman Corporation recorded on Reel/Frame 013751/0849.

**Related Appeals and Interferences**

There are no other appeals or interferences known to the Appellant or the Appellant's representative, which are believed to directly affect or be directly affected by or have a bearing on the Board's decision in the pending appeal.

**Status Of Claims**

Claims 1-20 are pending. Claims 4, 8-10, 14 and 18-20 are allowed. Claims 1, 2, 5, 6, 11, 12 and 15 stand rejected under 35 USC §103 as being unpatentable over Barabash et

al US patent no. 5,640,417 ("Barabash"). Claims 3, 7, 13 and 17 stand rejected under 35 USC §103 as being unpatentable over Barabash, further in view of Sotome et al US patent no. 5,761,216 ("Sotome"). The final rejection of these claims forms the basis for this appeal.

### Status Of Amendments

All previous amendments have been entered.

### Summary Of The Invention

The present invention relates to an improved decoding technique useful for use with hard decision decoding techniques, such as phase shift keying (PSK) and quadrature amplification modulation (QAM), as well as soft decision techniques, such as Viterbi decoding and trellis decoding techniques. The system in accordance with the present invention provides adaptive decision regions for hard decision decoding techniques and adaptive metrics for soft decision decoding techniques in which the decision boundaries and reference constellations are optimized in order to minimize the bit error rate (BER). The decision boundaries and metrics are optimized based on the locations of the received constellation points. By adaptively adjusting the decision boundaries and metrics, the BER is greatly improved.

Fig. 4 illustrates an ideal condition in which the constellation points  $\pm A$  are equidistant from the decision boundary. The additive white Gaussian noise (AWGN) probability density functions are shown below for the two constellation points  $\pm A$ . As shown, the modulator output points are transmitted with equal probability, providing maximum likelihood decision making which minimizes the BER.

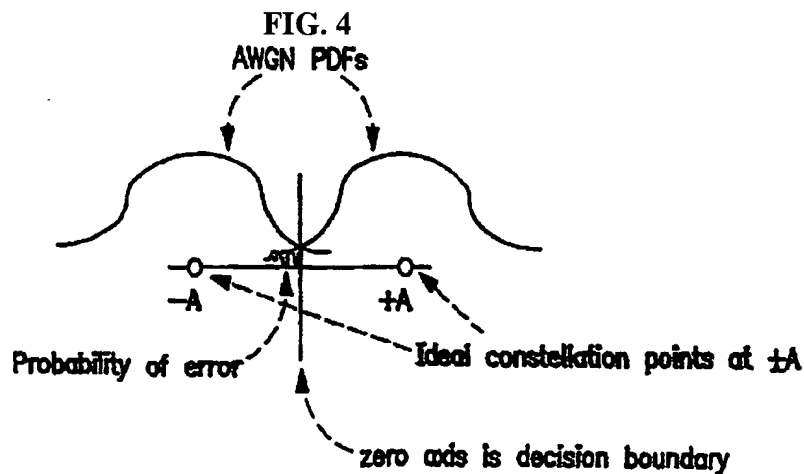


Fig. 5 illustrates a non-ideal condition in which the constellation points  $+B$  and  $-C$  have uncalibrated biases, due to, for example modem imperfections, amplifier non-linearities and the like. As shown, the constellation points  $+B$  and  $-C$  are no longer equidistant to the decision boundary. As such, the decision boundary no longer provides the maximum likelihood of probability, resulting in an increased probability of error thereby increasing the BER.

FIG. 5

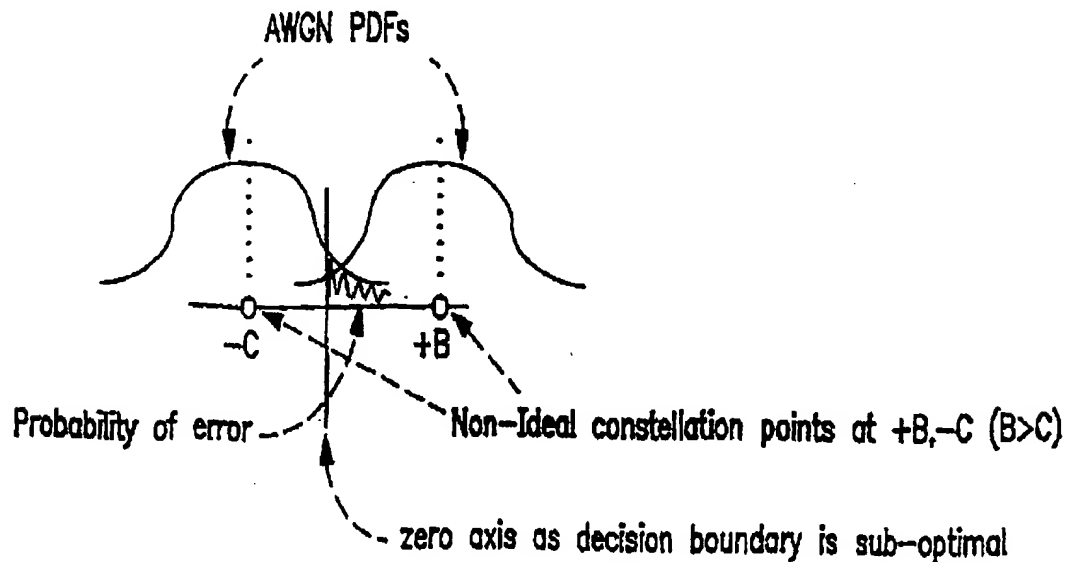


FIG. 5

In accordance with the present invention, as shown in Fig. 6, the decision boundary is adjusted to compensate for the constellation bias. In particular, with reference to Fig. 6, the original decision boundary is shown in solid line for the condition illustrated in Fig. 5. The adjusted decision boundary is shown in dotted line. In accordance with the present invention, the adjusted decision boundary is determined by simply determining the distance between the two symbols and dividing that value in half. In other words, for  $B > C$ , the decision boundary is determined simply as  $(B-C)/2$ . Once the decision boundary is adjusted, the probability of error is the same as the ideal condition, as illustrated in Fig. 4.

FIG. 6

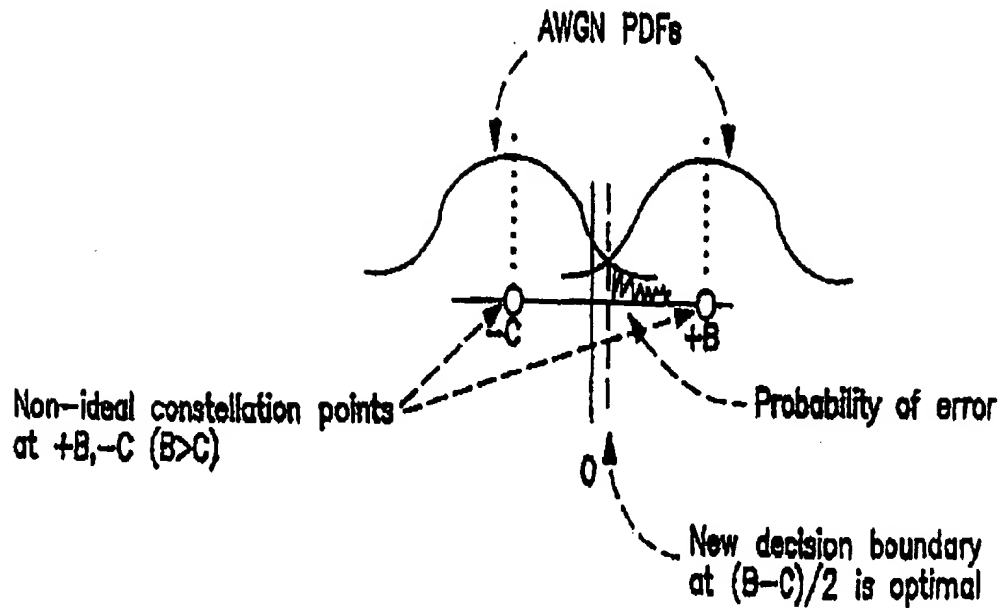


FIG. 6

### Issues on Appeal

- I. Whether the Board should reverse the rejection of claims 1, 2, 5, 6, 11, 12, and 15 under 35 U.S.C. § 103(a) as being unpatentable over the Barabash patent.
- II. Whether the Board should reverse the rejection of claims 3, 7, 13 and 17 under 35 U.S.C. § 103(a) as being unpatentable over the Barabash patent further in view of the Sotome patent.

### Grouping of Claims

It is respectfully submitted that the claims stand or fall together.

### Argument

#### *I. Rejection of Claims 1, 2, 5, 6, 11, 12, and 15 under 35 U.S.C. § 103(a) as being unpatentable over the Barabash patent.*

Claims 1, 2, 5, 6, 11, 12, and 15 were rejected under 35 U.S.C. § 103(a) as being unpatentable over the Barabash patent. In support of the rejection, paragraph 3 of the Detailed Action states that "Barabash et al teaches 'a system for adjusting initial boundaries'". The Examiner acknowledges on page 3 of the Detailed Action and the

Applicant agrees that the Barabash patent does not teach a system for determining the actual distance between the received signals. However, the Examiner states that:

“(Barabash) proposes selecting a boundary, the radius X, in such a way to optimize the probability of discriminating between one innermost symbol and three outermost symbols in a constellation. This computation for all practical purposes suggests a motivation to dynamically find a midpoint for distinguishing between the innermost symbols and the outmost symbols and using the half distance as the midpoint in a simple approach. Thus, it would have been obvious to one skill in the art at the time the invention was made to compute the distance between the innermost and outer symbols and select the symbol decision boundary using half the distance as a way to optimize the probability of discriminating between one innermost symbol and three outmost symbols in a constellation.”

It is respectfully submitted that the Examiner has failed to set forth a *prima facie* case of obviousness. In particular, as set forth in the Manual of Patent Examining Procedure (MPEP) §§ 2142 and 2143, in order to establish a *prima facie* case of obviousness, three criteria must be met as follows:

First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art references (or references when combined) must teach or suggest all of the claim limitations.

The MPEP also states that the teaching or suggestion to make the claimed invention must be found in the prior art and not the Applicant’s disclosure.

As stated by the Examiner and as set forth in column 6, line 66 through column 7, line 8 of the Barabash patent, the discrimination of the symbols is optimized based upon a radius X. Indeed, the radius X is selected to optimize the probability of discriminating between one innermost symbol and three outermost symbols. The radius X is computed from the probability distribution function for each of the four symbols. The decision boundary X is determined as illustrated in Fig. 4 of the Barabash patent.



FIG. 4 US Patent No. 5,640,417

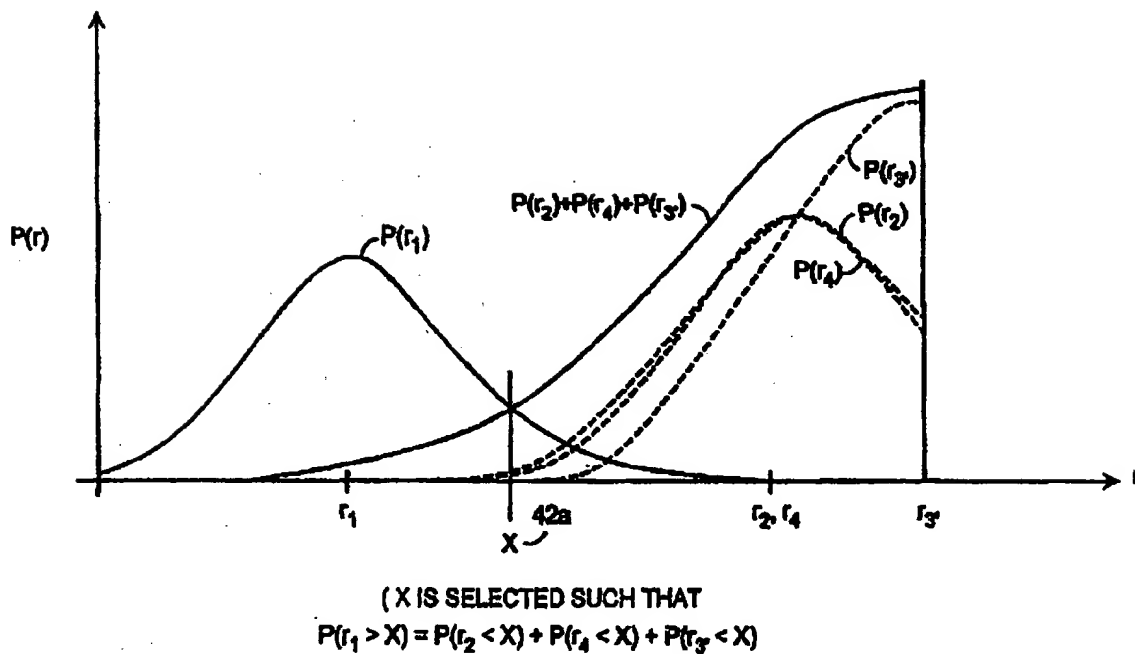


FIG. 4

It should be clear that the adjustment of the decision boundaries as taught by the Barabash patent is computation intensive and is extremely complicated relative to the system in accordance with the present invention. Indeed, the Barabash patent teaches first determining the probability distribution function for each of the four symbols and subsequently determining the decision boundary as illustrated in Fig. 4. It is respectfully submitted that the complicated and computation intensive method of Barabash can hardly be considered to suggest the relatively simple method recited in the claims at issue. Indeed, the system in accordance with the present invention does not need to determine the probability distribution functions of the received signals. Rather, the system in accordance with the present invention simply adjusts the decision boundary so that it is equidistant between two successive signals. By doing so, as mentioned above, the adjusted decision region boundary provides the maximum likelihood of probability thereby minimizing the BER without calculating any probabilities at all. For all of the above reasons, it is respectfully submitted that the Examiner has failed to make out a *prima facie* case of obviousness. The Board is respectfully requested to reverse the Examiner's rejection of 2, 5, 6, 11, 12, and 15 under 35 U.S.C. § 103(a) as being unpatentable over the Barabash patent.

**II. Rejection of Claims 3, 7, 13 and 17 under 35 U.S.C. § 103(a) as being unpatentable over the Barabash patent and further in view of the Sotome et al patent.**

Claims 3, 7, 13 and 17 were rejected under 35 U.S.C. §103(a) as being unpatentable over the Barabash patent further in view of the Sotome patent. In support of the rejection, the Examiner stated that:


“Barabash et al. discloses all the subject matter claimed except for ‘a symbol error counter for comparing said decoded signals to a predetermined training sequence to further improve the bit error rate.’ Sotome et al. teaches an error counter that counts errors by comparing a signal to be measured with a reference pattern for the purpose of measuring bit error. See FIG. 18A. Thus, it would have been obvious to one skilled to the art at the time the invention was made to add an error counter such as taught by Sotome et al. to the decoder stage of Barabash et al for the purpose of measuring bit error which is a critical communication characteristic when bit error rate is to be reduced thereby improving communication system.”

It is respectfully submitted that the Barabash et al patent does not disclose all of the subject matter claimed in the claims 3, 7, 13, and 17 as discussed above. The Sotome patent was sighted for teaching an error counter that counts errors by comparing a received signal with a reference pattern. The Sotome patent does not otherwise disclose a system for adjusting the decision boundaries based on a computation on the actual distances between received symbols. For these reasons and the above reasons, the Board is respectfully requested to reverse the Examiner’s rejection of claims 3, 7, 13, 17.

Conclusion

The Board is respectfully requested to reverse the rejection of the claims 1-3, 5-7, 11-13 and 15-17 by the Examiner.

Respectfully Submitted,

  
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